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Motor Carrier Type and Factors Associated with Fatal Bus Crashes 1999 and 2000

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16. Abstract

In 2000, the Federal Motor Carrier Safety Administration's (FMCSA) regulatory responsibilities were extended to buses with seating for nine or more occupants, including the driver, transported for compensation. FMCSA has also begun supporting data collection on buses involved in fatal crashes, to enhance information on the buses involved and the motor carriers that operate them. In response, the Transportation Safety Analysis Division at the University of Michigan Transportation Research Institute (UMTRI) initiated the Buses Involved in Fatal Accidents (BIFA) project to collect much more detailed information about buses involved in fatal crashes.

The present study focuses on factors associated with fatal bus crashes involving different bus operator types. Five different carrier types are identified: School, transit, intercity, charter/tour, and "other" bus operators. There are substantial differences between these carrier types that are reflected in many aspects of the crashes they are involved in, including when and where the crashes occur, who is injured in them, the configuration of the crash, the previous driving record of the bus drivers, and the frequency of driving errors related to the crash.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	Inches	25.4	millimeters	mm
ft	Feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kpa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
rnL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or “t”)	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celcius temperature	**1.8C + 32**	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

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Motor Carrier Type and Factors Associated with Fatal Bus Crashes

Introduction

An estimated 54,000 buses are involved in a traffic accident each year, including about 300 in fatal crashes, 12,000 in crashes involving injury, and 42,000 in crashes with only property damage.[1][1] While the number of buses in crashes is small in relation to other vehicle types (429,000 trucks, 3.9 million light trucks, and 6.7 million passenger cars annually), there has been an increased focus on the safety of bus operations recently. In 2000, the Federal Motor Carrier Safety Administration's (FMCSA) regulatory responsibilities were extended to buses with seating for nine or more occupants, including the driver, transported for compensation. FMCSA has also begun supporting data collection on buses involved in fatal crashes, to better understand the buses involved and the motor carriers that operate them.

In 2000, the Transportation Safety Analysis Division at the University of Michigan Transportation Research Institute (UMTRI) initiated a survey called the Buses Involved in Fatal Accidents (BIFA) project. This crash data collection, supported by FMCSA, supplements the standard data collected on all fatal crashes by the National Highway Traffic Safety Administration. Since the BIFA survey focuses on buses alone, it can provide a much more detailed description of each bus involved in a fatal crash and the carrier that operated it.

The BIFA survey significantly improves the identification of buses and bus operators. Descriptions of buses in nationally-representative crash data files has been relatively simple or lacking altogether. Up until recently, the most important national file on fatal crashes, the Fatality Analysis Reporting System (FARS) file, has only distinguished "school," "cross-country/intercity," "transit," and "other" bus types. The fact that common terminology for buses mixes physical characteristics with how they are operated adds to the difficulty in determining the scope and nature of bus safety problems. "School bus" connotes an identifiable bus type, but school buses often are converted to other uses. "Cross country" buses can be used by scheduled intercity carriers or as charter/tour buses or for private, personal transportation. In addition, both the vehicles used as buses and the entities that operate them are very diverse, including, along with the usual types, hospitals and nursing homes, non-profit organizations and churches, shuttle

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[1] Numbers in square brackets refer to references at the end of the paper.

services, and private companies. The BIFA survey was designed to capture this diversity. Enhancing the depth and detail of information on bus types and bus operators will improve our understanding of the different safety issues in bus transportation.

Putcha surveyed bus accidents using the major national databases, FARS and NHTSA's General Estimates System (GES), noting the lack of information on bus crashes, in comparison to other vehicle types.[7] Most studies of bus traffic safety have focused on specific bus types, often using regional or local crash datasets. Jovanis, et al., for example, studied transit bus crashes in the Chicago metropolitan area to identify the factors contributing to these crashes.[6] Hughes and Rodgman provided descriptive statistics on commercial buses (excluding school and "activity" buses) in North Carolina.[5] Foreman, et. al., reviewed national transit bus crashes but the study data was drawn from crash files in only a few states in which transit buses could be identified.[4]

More recently, Ellis et al. took up the problem of characterizing the scope and nature of the traffic safety problem associated with *camionetas*—small, irregular-route buses.[3] *Camionetas* are thought to be a growing component of passenger transportation in some areas, but they are very difficult if not impossible to identify in crash data. Finally, Thomas Corsi et al., looked at the overall safety performance of the bus industry, using national data files. But the data files used covered only interstate motor carriers, missing intrastate, transit, school and local operations.[2] The fact is that, while the situation is improving, most notably recent changes in the FARS file and the establishment of the BIFA project, crash data files provide relatively little detail concerning bus types and operations, especially in comparison with other vehicle types.

This study focuses on factors associated with fatal bus crashes involving different bus operator types. All fatal bus crashes occurring in the United States in 1999 and 2000 are included. Five different carrier types are identified: School, transit, intercity, charter/tour, and "other" bus operators. There are substantial differences between these carrier types that are reflected in many aspects of the crashes they are involved in, including when and where the crashes occur, who is injured in them, the configuration of the crash, the previous driving record of the bus drivers, and the frequency of driving errors related to the crash. These differences reinforce the point that in discussing "bus safety" it is necessary to distinguish among the segments of the passenger transportation industry.

Data

Data from the first two years, 1999 and 2000, of the Buses Involved in Fatal Accidents (BIFA) survey are used here. Modeled on UMTRI's Trucks Involved in Fatal Accidents (TIFA) program, the BIFA survey collects detailed information on all buses involved in fatal traffic crashes. For the purpose of the survey, a bus is defined as a vehicle with seating for nine or more occupants, including the driver, not for personal use (such as a family), or for 15 or more passengers. Buses operated by private commercial or non-profit organizations are included.

Cases for the BIFA survey are selected from the FARS file, and supplement FARS data with a detailed description of the bus, the bus operator, type of trip, driver hours driving, type of driver compensation, and role of the bus in the crash.

Throughout this paper, we classify buses by the type of "carrier" operating them. Carrier here is determined by the type of operations. Thus, if a bus is used to transport pupils, it is classified as a school bus. If a "school bus," that is, a bus of the type commonly used by schools, is used by a private company to transport employees, it is classified as a private company bus. In most cases, the physical configuration of most school, transit, intercity, and charter buses corresponded to the expected type for each. The five carrier types distinguished here are defined as follows:

School—Any public or private school or district, or contracted carrier operation on behalf of the entity, providing transportation for K-12 pupils.

Transit—An entity providing passenger transportation over fixed, scheduled routes, within primarily urban geographical areas.

Intercity—A company providing for-hire, long-distance passenger transportation between cities over fixed routes with regular schedules.

Charter/tour—A company providing transportation on a for-hire basis, usually round-trip service for a tour group or outing. The transportation can be for a specific event or as part of a regular tour.

Other—All bus operations not included in the previous categories. Includes private companies providing transportation to their own employees, non-governmental organizations such as churches or non-profit groups, non-educational units of government such as departments of corrections, and private individuals. These groups can be identified by the BIFA survey, but there are not enough cases to justify separate treatment currently.

Two years of the BIFA survey are currently available. Because of the number of cases available, many of the relationships identified here are suggestive rather than conclusive. Nevertheless, even with relatively small sample sizes, many of the most important relationships identified are statistically significant. As more years of the BIFA survey are added, trends and relationships suggested here can be evaluated further.

Results

Table 1 shows the distribution of buses involved in fatal crashes in 1999-2000 by operator type, as defined above. The most common operation type is transporting K-12 students to and from school. About 41% of fatal involvements in 1999-2000 were accounted for by school buses. Urban transit buses are the second most common with 34.3%. Intercity and charter/tour bus

operators run large motor coaches designed for highway travel, and together they account for about 14% of fatal bus involvements, with charter buses accounting for 9.6% of involvements and scheduled intercity for 4.1%. Company buses, non-profits, buses operated by government agencies, hospitals, and medical service agencies account for the remaining buses.

Table 1 Buses Involved in Fatal Crashes
By Operator Type, BIFA 1999-2000

Bus type	N	%
School	284	41.1
Transit	237	34.3
Intercity	28	4.1
Charter	66	9.6
Private company	8	1.2
Non-profit organization	19	2.7
Government	8	1.2
Personal	1	0.1
Other	22	3.2
Unknown	18	2.6
Total	691	100.0

The distribution of fatalities can usefully serve to illustrate the differences between different operators of buses. Table 2 shows the distribution of fatally-injured persons in bus crashes by the type of bus involved in the crash. The table also identifies the person type of each fatality for each carrier type. (Only percentages are shown in the table to minimize the number of columns. The subtotal rows show the proportion of bus, other vehicle, and non-motorist fatalities for each bus type. The number of involvements for each bus type is shown in the bottom row.)

Table 2 Percentage Distribution of Fatalities by Bus Carrier Type and Person Type, BIFA 1999-2000

	School	Transit	Intercity	Charter	Other	Unk.	Total
Bus							
Driver	4.4	1.2	3.0	6.9	7.9	10.5	4.2
Passenger	5.1	1.2	6.1	28.4	27.6	5.3	9.1
Bus subtotal	*9.5*	*2.4*	*9.1*	*35.3*	*35.5*	*15.8*	*13.3*
Other vehicle							
Drivers	57.3	42.7	45.5	33.3	31.6	36.8	46.2
Passengers	17.4	12.6	24.2	15.7	18.4	5.3	15.7
Unknown occ. type	0.0	0.0	0.0	2.9	0.0	0.0	0.4
Other vehicle subtotal	*74.7*	*55.3*	*69.7*	*52.0*	*50.0*	*42.1*	*62.3*
Non-motorists							
In parked vehicle	0.0	0.8	0.0	0.0	0.0	0.0	0.3
Pedestrian	14.2	37.4	15.2	12.7	13.2	42.1	21.9
Bicyclist	1.6	4.1	6.1	0.0	1.3	0.0	2.3
Non-motorist subtotal	*15.8*	*42.3*	*21.2*	*12.7*	*14.5*	*42.1*	*24.4*
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total fatalities	316	246	33	102	76	19	790

A total of 790 persons were killed in traffic crashes involving buses in 1999-2000. Crashes involving school buses accounted for the greatest number, followed by transit buses and charter buses. For most bus types, only a small proportion of the fatal injuries are to occupants of the bus. (It should be noted that the total for charter buses is inflated by one tragic crash during 1999 in which 22 occupants of a charter bus were killed.) One might expect a high proportion of pedestrian fatalities in school bus involvements, given that passengers are frequently boarding, getting off, and moving around the buses. But in fact, pedestrians and bicyclists only account for 15.8% of fatalities in school bus crashes, far less than the 41.5% in crashes involving transit buses. Instead, almost 75% of the fatalities in school bus crashes are occupants of other vehicles in the crash, indicating that the predominant crash type for school buses is a collision with another vehicle.

Over half the fatalities in transit bus crashes are to occupants of other motor vehicles, but pedestrians and bicyclists account for another 41% of fatalities. Over-the-road charter buses have a somewhat higher proportion of in-vehicle fatalities (though this bus category is exaggerated by a single crash with a very large loss of life), but 70% of fatalities in crashes with intercity buses are to occupants of other vehicles in the crash, and the proportion of pedestrian/bicyclist fatalities is 21.2% On the other hand, non-motorists account for 12.7% of charter bus fatalities, a proportion that would be higher but for a single anomalous crash. In fact, but for the crash with a large loss of life, the distribution of fatalities by the type of person for charter bus crashes would be quite similar to that of scheduled intercity buses.

Differences in when bus crashes occur by month, day of week, and even hour of the day clearly separate the different bus operator types (Figure 1). Fatal traffic crashes involving school buses occur primarily between September and May, that is, during the school year. Transit bus fatal involvements are more evenly distributed over the year. In the figure, intercity and charter/tour bus involvements are combined. The curve shows a peak in June, with a steady increase from July through December.

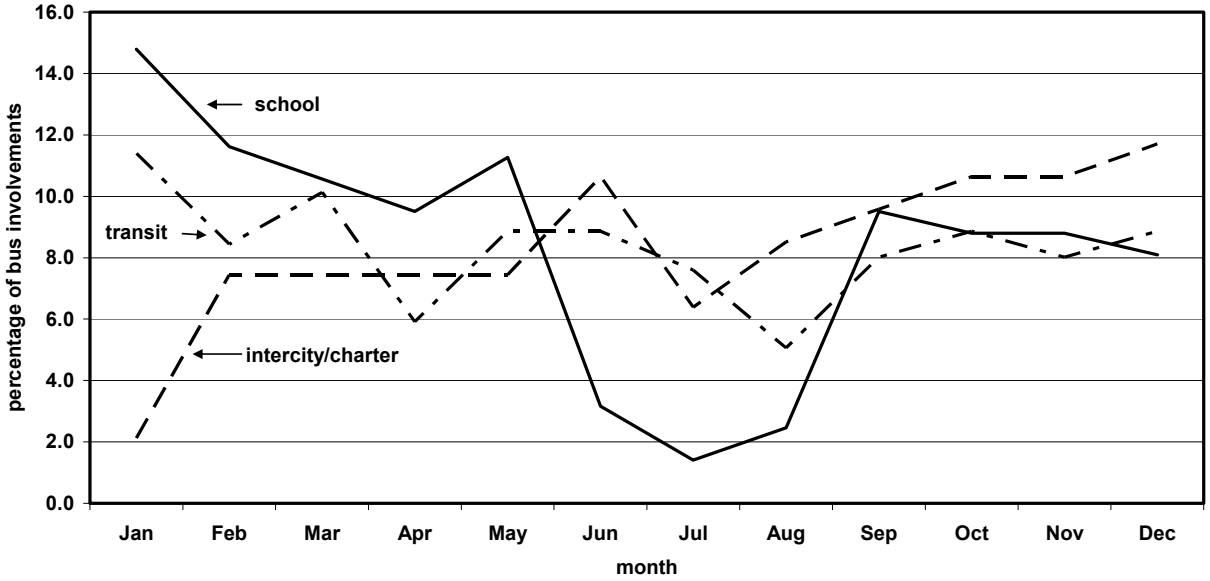

Figure 1 Bus Involvements in Fatal Crashes by Operator Type and Month, BIFA 1999-2000

Across the week, school bus involvements occur almost entirely Monday through Friday, with only 2.8% on the weekend. In contrast, transit bus involvements are relatively evenly distributed across the week. Almost 20% of transit bus fatal involvements are on the weekend, because transit buses operate throughout the week. There were only 28 scheduled intercity buses involved in a fatal traffic accident in 1999-2000, so the weekly distribution is probably not meaningful, but it should be noted that 17.8% occurred on a weekend. In contrast, almost 41% of charter bus crashes occurred on the weekend, probably because much of their travel is related to leisure activities.

Figure 2 shows the distribution of bus involvements in fatal traffic crashes by time of day. Again the different operator types clearly show different patterns of occurrence. School bus involvements peak around the times school begins and ends. Transit bus involvements are more evenly distributed across the 24 hours, with peaks in the morning and afternoon rush hours, and a lesser peak around noon. Intercity and charter bus involvements are again combined because of the small number of cases, but show relatively evenly distributed involvements, reflecting significant travel at all hours.

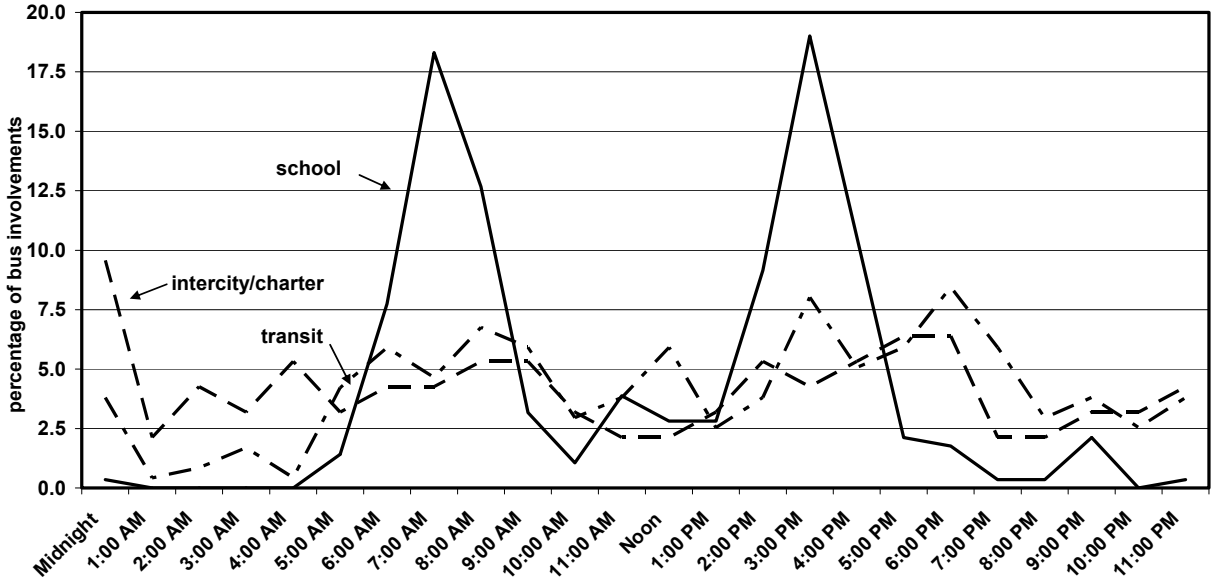

Figure 2 Bus Involvements in Fatal Crashes by Operator Type and Time of Day, BIFA 1999-2000

The type of roads and areas where the crashes occurred also show marked differences between the carrier types. These differences reflect where and how the buses are operated and thus the risks to which they are exposed. Over 40% of school bus fatal crash involvements occurred in urban areas, and almost all of those on either arterial roads or local streets, rather than freeways or Interstate highways. About 54% of school bus crashes were in rural areas, and again, the crashes occurred on arterial and local roads as the buses move through residential areas to pick up or drop off students. In contrast, about 88% of the fatal traffic crashes of transit buses happened on urban roads, and almost 10% on urban Interstates or freeways. Urban arterial roads accounted for almost 58.4% of the involvements.

The crash involvements of intercity and charter buses also reflect their usage, but differences between those carrier types probably also reflect contrasting modes of operation. Half of crashes involving intercity buses are in rural areas, with almost all of those on Interstates or other major, divided roads. Similarly, in urban areas the crashes of scheduled intercity occurred on major divided highways such as Interstates, expressways, or other principal arterial roads. Charter/tour bus fatal crashes also occurred primarily on Interstate or expressway-type roads, but a somewhat higher proportion occurred on local roads and streets. Rural areas accounted for over half of charter/tour bus fatal crashes.

The types of crashes also vary by bus operator type, reflecting differences in operations. Almost 20% of school bus fatal involvements were single-vehicle, but that proportion is actually lower than the overall percentage for all fatal bus crashes. (See Table 3.) Virtually all of these were collisions with pedestrians or bicyclists. Rear-end crashes accounted for about 15% of their involvements, and in almost all, the school bus was struck in the rear. Almost 40% of transit bus crashes were single vehicle, and again almost all of these were pedestrian/bicyclist collisions.

Transit buses had about the same proportion of rear-end crashes as school buses, and like school bus crashes, the bus was the struck in the rear in almost all their rear-end crashes, rather than striking the other vehicle in the rear. Intercity and charter bus crashes show strikingly different patterns, but patterns that are consistent with different usages shown in the road type results reported above. For both types, when involved in a rear-end collision, they were about equally likely to be the striking vehicle or the struck vehicle. Charter and intercity buses have higher proportions of single-vehicle crashes than school buses, due to a higher percentage of ran-off road crashes. Note, however, that head-on crashes are more likely to occur in the bus's lane than in the other vehicle's lane, for each bus type. In other words, in head-on crashes involving buses, in almost all cases the other vehicle crosses the center line into the bus's lane of travel.

Table 3 Percentage Distribution of Crash Type by Bus Operator Type, BIFA 1999-2000

Accident type	School	Transit	Intercity	Charter	Other	Unknown	Total
Single vehicle							
Ran off road	2.1	0.0	7.1	7.6	17.2	0.0	3.3
Hit object in road	16.9	39.2	21.4	18.2	19.0	44.4	25.8
Same direction, same trafficway							
Rear-end, bus striking	1.1	1.3	3.6	10.6	1.7	5.6	2.3
Rear-end, bus struck	13.4	14.3	3.6	9.1	6.9	0.0	12.0
Sideswipe, in other's lane	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sideswipe, in bus's lane	0.7	1.3	0.0	1.5	0.0	0.0	0.9
Opposite direction, same trafficway							
Head-on, in other's lane	1.1	0.0	0.0	3.0	1.7	0.0	0.9
Head-on, in bus's lane	20.1	8.9	21.4	9.1	6.9	5.6	13.7
Sideswipe, in other's lane	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sideswipe, in bus's lane	3.5	0.8	0.0	0.0	5.2	5.6	2.3
Change trafficway, one vehicle turning							
Bus turn across path	8.5	3.4	7.1	1.5	3.4	0.0	5.4
Other turn across path	5.6	3.4	3.6	1.5	5.2	5.6	4.3
Intersecting paths, both going straight							
Bus into side of other	7.4	8.0	7.1	7.6	6.9	0.0	7.4
Other into side of bus	5.6	2.5	7.1	1.5	1.7	0.0	3.8
Other accident types							
Other	10.6	9.7	17.9	25.8	20.7	16.7	13.0
Unknown	3.5	7.2	0.0	3.0	3.4	16.7	4.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N =	284	237	28	66	58	18	691

Certain crash types can indicate driver error or driver contribution to the crash. In rear-end crashes, the error leading to the crash is much more likely to have occurred in the striking vehicle than in the struck. Similarly, in head-on crashes, the vehicle crossing the centerline is much more often "at-fault" in the crash than the other vehicle. Other crash types are not so clear-cut in the absence of information on right-of-way. Currently there is not sufficient sample size to do more than note some suggestive differences between the carrier types.

However, the BIFA file includes information on driver errors and the previous driving record of the drivers, which show significant differences among the carrier types. Table 5 shows driver errors and other "driver-related factors" coded for the drivers of the different bus carrier types. These driver-related factors are coded by FARS analysts when compiling the FARS file, which the BIFA survey supplements. The driver-related factors variables (up to four may be coded) are used to record driving errors and other driver actions or conditions that may have contributed to the crash.

The primary driver errors coded are "failure to yield," "inattention," "excessive speed," and "ran off the road." "Fatigue" was coded for only nine of the 691 bus involvements, and "inattention" for 32. (Fatigue and inattention are likely underreported, since, unlike alcohol or drug use, they are difficult to identify after the fact.) Table 4 shows the most frequent driver errors coded for the different carrier types. Failure to yield was a common driver error for all carrier types, with about seven to ten percent of drivers for each carrier type coded as failing to yield. About 10.3% of drivers of the "other" carrier type—typically nonprofit organizations or private companies transporting their own employees—were coded as inattentive, and another 8.6% as drowsy or asleep. On the other hand, 15.2% of charter/tour bus drivers were coded as driving too fast, twice the proportion of any other carrier type.

Table 4 Percentage of Selected Driver Errors by Carrier Type, BIFA 1999-2000

Driver error	School	Transit	Intercity	Charter	Other	Unknown	Total
Failure to yield	10.2	8.4	10.7	7.6	8.6	11.1	9.3
Inattentive	4.2	3.4	0.0	6.1	10.3	11.1	4.6
Driving too fast	0.4	0.8	7.1	15.2	5.2	5.6	2.7
Run off road/lane	2.5	0.4	10.7	6.1	5.2	0.0	2.6
Failure to obey	2.8	0.8	0.0	4.5	0.0	0.0	1.9
Erratic/reckless	1.8	1.3	0.0	3.0	1.7	0.0	1.6
Drowsy, asleep	0.4	0.0	3.6	1.5	8.6	5.6	1.3
Other improper turn	1.1	1.3	0.0	0.0	3.4	0.0	1.2
Stopping in road	1.1	1.3	0.0	1.5	1.7	0.0	1.2
Running off road	0.7	0.4	0.0	0.0	6.9	0.0	1.0
Over-correcting	0.4	0.0	3.6	1.5	5.2	0.0	0.9

Table 5 provides insight into the overall coding of factors relating to the drivers operation of the bus. For this table, the factors are aggregated to either "driver errors," which are actions or omissions by the driver that in the FARS' analysts judgment contributed to the crash, or "other factors," which are conditions or events present that may have contributed to the crash. Typical other factors coded include vision obstructed by inclement weather or parts of the vehicle, and swerving to avoid a vehicle in the road. The results were quite similar for both school and transit bus drivers. Overall, about three-fourths of school and transit bus drivers were not considered to have committed any driving error or had any other factor associated in connection with the crash. The comparable percentages for intercity and charter/tour bus drivers were lower. About 65% of

intercity drivers did not have any factor coded, and only 60.6% of charter/tour bus drivers had no driver factor coded. A driver error was coded for 20.4% of school bus drivers, and another related factor was coded for 7.4%. For transit bus drivers, the proportions were 16.5% and 9.3%. In contrast, both scheduled intercity and charter/tour bus drivers had higher proportions of driver errors coded; scheduled intercity bus drivers also had a slightly higher proportion of other factors coded. (Up to four driver-related factors may be coded, so the proportions do not sum to the "any factor coded" cell because both a driving error and another factor can be coded for the same driver.)

Table 5 Driver Error and Other Driver-Related Factors by Carrier Type, BIFA 1999-2000

Driver factor coded	School	Transit	Intercity	Charter	Other	Unknown	Total
None	72.5	75.9	64.3	60.6	60.3	61.1	70.9
Driver error	20.4	16.5	28.6	36.4*	37.9*	27.8	22.6
Other factor coded	7.4	9.3	10.7	9.1	6.9	16.7	8.5
Any factor coded	27.5	24.0	35.7	39.4	39.7	38.9	29.1
N =	284	237	28	66	58	18	691

* Statistically different from school bus proportions at 0.05 level.

Statistical tests were performed to determine the reliability of the differences, given sample sizes, at the 0.05 level. School buses were taken as the baseline case, to which the other carrier types were compared because they had the smallest proportion of factors coded and because of the relatively large sample of school bus fatal involvements. Only charter/tour and "other" carrier type drivers differed significantly from school bus drivers. Over 36 percent of charter/tour bus drivers were coded with a driving error, compared with 20.4% of school bus drivers. And almost 38% of the "other" carrier type drivers committed a driving error that contributed to the crash.

There are also significant differences by carrier type with respect to the previous driving record of the drivers. Table 6 shows the incidence in the three years prior to the crash of accidents, suspensions, DWI convictions, speeding, and other moving violations. We have included the records of passenger car and truck drivers involved in fatal crashes for comparison. As with driver errors, school bus drivers were defined as the baseline case for other bus drivers, and statistical tests were performed to determine the reliability of the differences. The proportions for car and truck drivers are compared with the proportions for all bus drivers.

Table 6 Percentage of Drivers with Selected Previous Accidents or Violations by Carrier Type, BIFA 1999-2000, TIFA 1999-2000, FARS 1999-2000

Driver history	School	Transit	Inter-city	Charter	Other	All buses	Cars	Trucks
Accidents	18.1	25.9*	29.2	31.2*	17.0	22.7	14.8**	18.8**
Suspensions	4.6	3.9	0.0*	11.1*	14.3*	5.7	12.7**	8.9**
DWI	0.0	1.8*	0.0	0.0	0.0	0.6	3.3**	1.1
Speeding	11.4	14.9	7.4	20.6	10.7	13.4	19.8**	28.8**
Other moving violations	11.4	15.7	18.5	17.5	21.4	14.9	16.5	25.3**
All violations	21.4	29.3*	25.9	33.3	32.1	26.9	35.1**	45.9**
Any violation or accident	36.0	47.6*	52.0	50.0*	43.6	43.2	42.4	54.3**
N*** =	265	220	24	61	53	639	64,880	9,497

* Statistically different from school bus proportions at 0.05 level.

** Statistically different from all bus proportions at 0.05 level.

*** N shown is the smallest number of cases with complete data for any item. Significance tests were calculated using the number of cases with complete data for each item.

The previous driving record of school bus drivers shows the lowest incidence of previous accidents or violations, whether compared to other carrier types, car drivers, or truck drivers. School bus drivers also among the lowest when the individual violation types are considered, such as license suspensions, speeding violations, or other moving violations. Only some of the differences are statistically significant in these data. Less than two percent of transit drivers had a previous DWI conviction in the prior three years, but no bus driver for the other carrier types had such a conviction. Transit bus drivers also had higher proportions of previous accidents, speeding and other moving violations. These differences are not statistically significant taken separately, but when combined, to measure any previous moving violation or any violation or accident, transit bus drivers had significantly worse driving records than school bus drivers.

Scheduled intercity bus drivers also had driving records with higher proportions of violations or either a violation or a crash, but the sample size for intercity drivers is not large enough to attain statistical significance. However, charter/tour bus drivers had higher proportions on each measure except for DWI, and the differences were statistically significant at the 0.05 level for previous accidents and any violation or accident. Differences on the other dimensions are substantial, but not large enough to be statistically significant at the 0.05 level. Almost one-third of charter bus drivers had a previous crash compared with 18.1% of school bus drivers. Over 11% of charter bus drivers had been suspended in the previous three years, compared with only 4.6% of school bus drivers.

It was hypothesized that previous driving records are related to driver errors in the crash, as coded in the driver-related factors variables, such that drivers with poor driving records would be more likely to commit driving errors in the present crash. However, no such relationship could be detected in these data. There was a weak association between other related factors in the current crash and any previous violation, but no other association was found.

Discussion

Motor carrier type has a significant effect on virtually all aspects of the experience of buses in fatal traffic accidents. Suggestive differences were found between the four primary carrier types defined here—school, transit, scheduled intercity, and charter/tour—in virtually every dimension examined. These differences were reflected in the time of the crashes, the area and roads on which the crashes occurred, and who in the crash is at greatest risk of fatal injury.

Fatal crashes involving school buses occur primarily during the school year and the work week, with peaks in the morning and afternoon. Most of their crashes occur on local roads and streets, as the students are picked up or dropped off. Though one might expect a higher proportion of pedestrian involvements, since children are moving around the bus as they board or egress, pedestrian fatalities were actually a lower proportion of total fatalities than for transit buses, and comparable to charter and "other" buses. The most frequent crash types involving school buses were head-on crashes and rear-end crashes. In the head-on crashes, almost all occurred when another vehicle crossed the centerline and struck the bus. Similarly, most rear-end crashes occurred when another vehicle struck the bus in the rear. Almost 80% of fatalities occurred in the vehicles striking the bus.

The fatal involvements of transit buses are more evenly distributed around the year and across the week, though numbers are somewhat lower in the summer months than in the rest of the year. About 20% of transit bus crashes occur on the weekend, and while the daily pattern shows increases at the morning and evening rush hours, there are substantial numbers of transit bus fatal involvements up to midnight. Most transit bus fatal involvements occur in urban areas, as would be expected, and on primary arterial roads. Over 42% of the fatalities in transit bus crashes are non-motorists, either pedestrians or bicyclists, and about 55% occur to occupants of other vehicles. Collisions with pedestrians or bicyclists is the largest crash type for transit buses; and in rear-end crashes, most occur with the other vehicle striking the bus while stopped.

Scheduled intercity buses and charter buses have some similarities because both are operated more often on high-speed roads on long-haul trips, but there are significant differences. The crashes of intercity buses most often occur on Interstate or expressway-type roads in rural areas. Charter bus crashes also occur primarily on high-speed roads, but a higher proportion occur on local roads or in urban areas. The most common crash type for intercity buses was the head-on collision, occurring in every case in the bus's lane. Rear-end crashes were proportionally of about the same magnitude as school bus and transit bus crashes, but in sharp contrast with those bus types, intercity and charter buses were about as likely to be the striking vehicle in rear-end crashes as they were to be struck. Small sample sizes, particularly for intercity buses, limit conclusions, but additional years of data may validate these relationships.

In terms of previous driver record and driver errors in the crash, significant differences were also found among the carrier types examined. Some of these differences were great enough to be statistically significant, even given the limited data available. School bus drivers had the best driving record and were coded with the fewest driving errors in the crash, compared with the other bus carrier types. Both intercity and charter/tour bus drivers had much higher proportions than school bus drivers on most of the measures. Statistical significance could not be established for intercity drivers because there were only twenty-eight cases for 1999-2000, but the differences for charter bus drivers were both large and statistically significant. Fully one-half of charter bus drivers had a conviction, suspension, or crash in the three years prior to the crash, compared with only about one-third of school bus drivers. And 36.4% of charter bus drivers were coded with a driving error in the current crash, compared with 20.4% of school bus drivers. This difference was statistically significant at the 0.05 level.

The differences uncovered in this analysis have implications for safety improvements and validate the approach taken in the BIFA survey. Motor carrier type plays a major role in fatal bus crash involvements and, even at the exploratory level undertaken in this study, point to quite different safety interventions, depending on the operation type. Pedestrian/bicyclist crashes are of course a problem for school buses and improved driver vision around the bus remains an issue. But the high proportion of rear-end crashes in which the bus is struck suggests that conspicuity and awareness that the bus is stopped is also a target. Driver vision around the bus is clearly a major issue for transit bus drivers, given the very high proportion of pedestrian/bicyclist collisions.

Driver issues are more of a focus for intercity and charter/tour bus operations, although the very small sample size for intercity involvements make any conclusion very tentative. But charter/tour bus operators have a significantly higher proportion of poor driving records and driving errors in the current crash.

Finally, this analysis has clearly shown that bus operation type must be accounted for in any bus safety analysis. Significant differences were found among the different types of bus operations, whether the characteristic examined was related to time, road type, area of operation, crash configuration, driver action, or driver record. These differences validate the approach taken in the BIFA survey, which is to separate bus body type from how the bus is operated and to provide a detailed description of the bus operator. Only some of the details available in the BIFA data set have been displayed here. Not all of the differences discussed here have been validated statistically, but as more years of the BIFA survey are accumulated, further testing can be undertaken. It is likely that the BIFA survey data, supplementing FARS and supported by the FMCSA, will prove to be a valuable resource in the future in studying bus safety issues.

References

1. *Traffic Safety Facts, 2001*. National Highway Traffic Safety Administration, National Center for Statistics and Analysis, U.S. Department of Transportation, Washington DC 20590. December 2002.

2. Corsi, T. M.; Newhouse, M. L.; Shukla, A.; Chandler, P. 2002. Passenger motor carriers: a safety performance profile. Maryland University, College Park, School of Business, Supply Chain Management Center/ Federal Motor Carrier Safety Administration, Commercial Passenger Carrier Safety Division, Washington, D.C. 26 p. Zacharia, Z. G., ed. Proceedings: International Truck and Bus Safety Research and Policy Symposium. Knoxville, Tenn., 2002, p. 523-548.

3. Ellis, D. R.; Hanley, P. 2002. Characteristics of camioneta van operations in Texas. Texas Transportation Institute, College Station/ Federal Motor Carrier Safety Administration, Washington, D.C. 11 p. Zacharia, Z. G., ed. Proceedings: International Truck and Bus Safety Research and Policy Symposium. Knoxville, Tenn., 2002, p. 511-521.

4. Foreman, C.; Rey, J. R.; DeAnnuntis, C. 2002. National transit bus accident data collection and analysis. South Florida University, National Center for Transit Research, Tampa. 72 p. Sponsor: Transportation Department, Research and Special Programs Administration, Washington, D.C.; Florida Department of Transportation, Tallahassee. Report No. NCTR-416-13.

5. Hughes, R. G.; Rodgman, E. A. 2000. Commercial bus crashes in North Carolina 1995 - 1999. North Carolina University, Chapel Hill, Highway Safety Research Center. 12 p. Sponsor: North Carolina State Department of Motor Vehicles, Raleigh.

6. Jovanis, Paul P.; Schofer, Joseph L.; Prevedouros, Panos; Tsunokawa, Koji. *Analysis of Bus Transit Accidents: Empirical, Methodological, and Policy Issues.* Northwestern Univ., Evanston, IL. Transportation Center. Sponsor: Urban Mass Transportation Administration, Washington, DC. Univ. Research and Training Program. Jun 1989. 109p.

7. Putcha, D. 2001. Bus accidents in the United States, 1995-1999. Michigan University, Ann Arbor, Transportation Research Institute, Systems Analysis Division. 34 p. Sponsor: American Bus Association, Washington, D.C. Report No. UMTRI-2001-17.